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Navajo County, Arizona

National Eutrophication Survey, Las Vegas, Nev

Prepared for

Environmental Monitoring and Support Lab, Las Vegas, Nev

Aug 77

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

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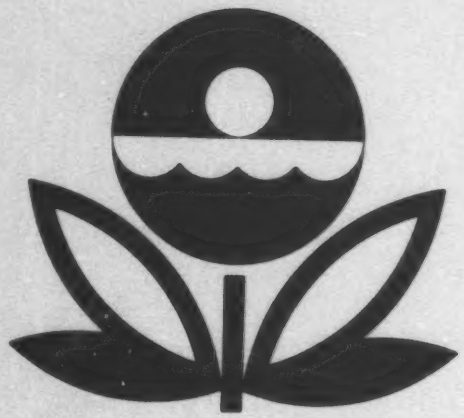

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT

ON

FOOLS HOLLOW LAKE

NAVAJO COUNTY

ARIZONA

EPA REGION IX

WORKING PAPER No. 727

WITH THE COOPERATION OF THE

ARIZONA STATE DEPARTMENT OF HEALTH

AND THE

ARIZONA NATIONAL GUARD

AUGUST, 1977

REPORT ON FOOLS HOLLOW LAKE

NAVAJO COUNTY, ARIZONA

EPA REGION IX

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 727

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

August 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Arizona State Department of Health for professional involvement, to the Arizona National Guard for conducting the tributary sampling phase of the Survey, and to those Arizona wastewater treatment plant operators who provided effluent samples and flow data.

The staffs of the Bureau of Water Quality Control, Environmental Health Services, Arizona State Department of Health, and the Arizona Game and Fish Department, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

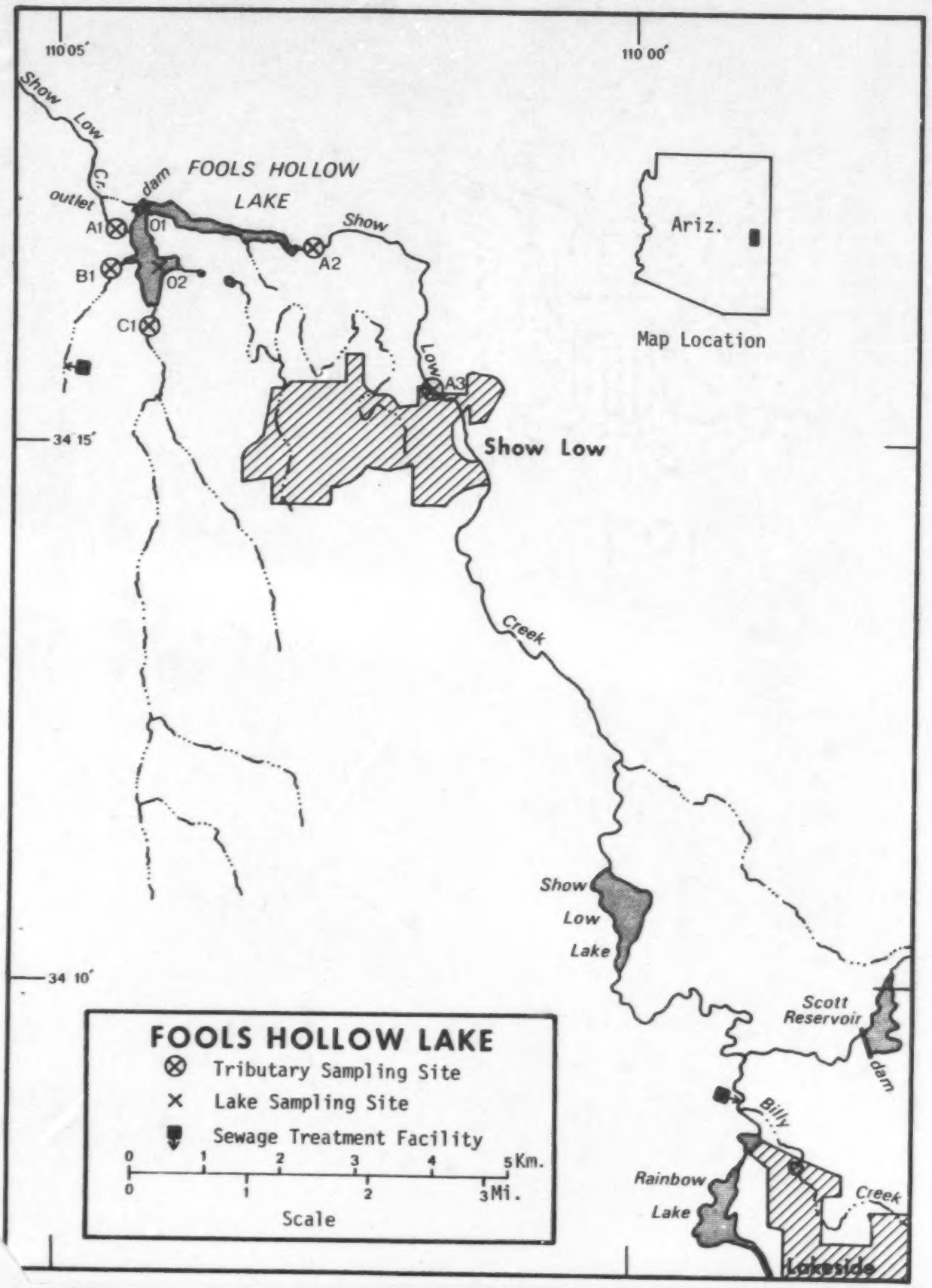
Major General John G. Smith, the Adjutant General of Arizona, and Project Officer Colonel Richard A. Colson, who directed the volunteer efforts of the Arizona National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF ARIZONA

LAKE NAME	COUNTY
Big Lake	Apache
Fools Hollow Lake	Navajo
Lake Havasu	Mohave (San Bernadino in CA)
Luna Lake	Apache
Lyman Lake	Apache
Lake Mohave	Mohave (Clark in NV)
Lake Pleasant	Yavapai, Maricopa
Lake Powell	Coconino (Kane, Garfield, San Juan in UT)
Rainbow Lake	Navajo
Theodore Roosevelt Lake	Gila
San Carlos Reservoir	Graham, Gila, Pinal


110 05'
110 00'
34 15'
34 10'
Show Low Cr.
outlet
dam
FOOLS HOLLOW LAKE
A1
O1
B1
O2
C1
Show
A2
Low
A3
Show Low
Ariz.
Map Location
Creek
Show Low Lake
Scott Reservoir
dam
Billy
Rainbow Lake
Creek
Lakeside
FOOLS HOLLOW LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 1 2 3 4 5 Km.
0 1 2 3 Mi.
Scale

REPORT ON FOOLS HOLLOW LAKE, ARIZONA

STORET NO. 0402

I. CONCLUSIONS

A. Trophic Condition:*

On the basis of field observations and Survey data, Fools Hollow Lake is considered eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Chlorophyll a values ranged from 8.7 µg/l to 11.9 µg/l with a mean of 10.7 µg/l. Potential for primary production as measured by algal assay control yields was moderately low in the spring and high in the fall. Hypolimnetic dissolved oxygen levels were depleted and hydrogen sulfide production was detected at Station 01 during June and October. Of the 11 Arizona lakes sampled in 1975, 2 had higher median total phosphorus levels (0.059 mg/l), 3 had higher median inorganic nitrogen values (0.090 mg/l) and 2 had higher median ortho-phosphorus levels (0.014 mg/l) than Fools Hollow Lake.

Survey limnologists reported no problem algal blooms or aquatic macrophyte growths during their visits to the lake.

*See Appendix E.

However, low Secchi disc visibility suggests primary productivity is light-limited in Fools Hollow Lake throughout at least the spring and summer sampling periods. The Arizona Department of Health Services (1976) classes Fools Hollow Lake as having unacceptable water quality due to its high phosphorus and turbidity levels, and oxygen content which is periodically unacceptably low for maintenance of a cold water fishery. The Arizona Game and Fish Department (J. Novy, Personal Communication) reports nuisance weed growth develops in all shallow areas of the lake during summer months.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Fools Hollow Lake was limited by available phosphorus during the spring sampling (03/04/75) and by available nitrogen during the fall (10/06/75). The lake data suggest nitrogen limitation at all three sampling times.

C. Nutrient Controllability:

1. Point sources -

During the sampling year, point sources were calculated to contribute 30.3% of the total phosphorus load to Fools Hollow Lake. The Fairway Park plant contributed 25.7% of the total load and the Lakeside Laundry Mat contributed 4.6%.

2. Nonpoint sources -

Nonpoint sources, including precipitation, contributed 69.7% of the total phosphorus load during the sampling year.

Show Low Creek contributed 44.2% and ungaged drainage areas were estimated to have contributed 18.6% of the total. The State of Arizona reports that the Little Colorado River Basin is, in general, phosphorus-rich as a result of natural runoff. However, septic tanks in Show Low, Lakeside and Pinetop, as well as agricultural runoff from surrounding crop land, are probably additional sources of nonpoint nutrient enrichment to Fools Hollow Lake (Arizona Department of Health Services, 1976). A planned sewage treatment facility for the Pinetop-Lakeside area which would pump effluent out of the drainage basin may result in reduced nutrient input to the lake (W. H. Shafer, personal communication).

The outlet of Fools Hollow Lake flows intermittently; thus no information is available on nutrient outflow from the lake during the 1975 sampling year. Additional sampling is needed to determine the true nutrient budget for Fools Hollow Lake before recommendations on controllability can be proposed.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry data were provided by Ned Rathbun (1974); average surface area and maximum volume at spillway are indicated. Tributary flow data were provided by the Arizona District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was estimated by dividing the lake volume by mean flow of the outlet (0.004 cms). Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 0.57 km^2.
2. Mean depth: 7.0 meters.
3. Maximum depth: 18.6 meters.
4. Volume: 3.968 x 10^6 m^3.
5. Mean hydraulic retention time: 11,481 days (31.4 yr).

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area (km^2)	Mean Flow (m^3/sec)
A-2 Show Low Creek	239.6	0.06
Minor tributaries and immediate drainage -	42.1	0.02
Total	281.7	0.08
2. Outlet - A-1 Show Low Creek	282.3	<0.01

C. Precipitation:

1. Year of sampling: 30.8 cm.
2. Mean annual: 63.2 cm.

III. LAKE WATER QUALITY SUMMARY

Fools Hollow Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 13.7 meters at Station 01 and 4.3 meters at Station 02. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

FOOLS HOLLOW
STORET CODE 0402

A. PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(3/ 4/75) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(6/19/75) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(10/ 6/75) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	4	3.3- 4.2	3.9	0.0- 1.5	4	15.4- 16.1	15.9	0.0- 1.5	4	18.8- 18.8	18.8	0.0- 1.5
MAX DEPTH**	2	2.3- 4.1	3.2	3.4- 10.7	2	10.4- 14.1	12.2	4.0- 11.0	2	15.1- 18.4	16.7	4.3- 13.7
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	4	10.2- 10.8	10.6	0.0- 1.5	4	4.8- 6.4	6.2	0.0- 1.5	4	7.6- 8.0	7.8	0.0- 1.5
MAX DEPTH**	2	8.2- 10.0	9.1	3.4- 10.7	2	0.2- 6.4	3.3	4.0- 11.0	2	2.0- 7.2	4.6	4.3- 13.7
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	4	212.- 222.	216.	0.0- 1.5	4	128.- 132.	131.	0.0- 1.5	4	149.- 153.	153.	0.0- 1.5
MAX DEPTH**	2	214.- 216.	215.	3.4- 10.7	2	112.- 124.	118.	4.0- 11.0	2	149.- 153.	151.	4.3- 13.7
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	4	8.6- 8.7	8.7	0.0- 1.5	4	6.8- 7.9	7.8	0.0- 1.5	4	8.8- 8.9	8.8	0.0- 1.5
MAX DEPTH**	2	7.9- 8.7	8.3	3.4- 10.7	2	7.1- 8.0	7.6	4.0- 11.0	2	7.9- 8.9	8.4	4.3- 13.7
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	4	96.- 99.	97.	0.0- 1.5	4	78.- 80.	78.	0.0- 1.5	4	80.- 84.	81.	0.0- 1.5
MAX DEPTH**	2	87.- 96.	92.	3.4- 10.7	2	77.- 79.	78.	4.0- 11.0	2	84.- 97.	91.	4.3- 13.7
TOTAL P (MG/L)												
0.-1.5 M DEPTH	4	0.023-0.059	0.029	0.0- 1.5	4	0.061-0.128	0.066	0.0- 1.5	4	0.039-0.064	0.049	0.0- 1.5
MAX DEPTH**	2	0.021-0.083	0.052	3.4- 10.7	2	0.060-0.101	0.080	4.0- 11.0	2	0.044-0.300	0.172	4.3- 13.7
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	4	0.006-0.015	0.008	0.0- 1.5	4	0.014-0.029	0.017	0.0- 1.5	4	0.009-0.017	0.011	0.0- 1.5
MAX DEPTH**	2	0.007-0.020	0.013	3.4- 10.7	2	0.010-0.029	0.019	4.0- 11.0	2	0.006-0.083	0.044	4.3- 13.7
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	4	0.050-0.070	0.060	0.0- 1.5	4	0.020-0.120	0.025	0.0- 1.5	4	0.020-0.020	0.020	0.0- 1.5
MAX DEPTH**	2	0.070-0.080	0.075	3.4- 10.7	2	0.020-0.030	0.025	4.0- 11.0	2	0.020-0.020	0.020	4.3- 13.7
AMMONIA (MG/L)												
0.-1.5 M DEPTH	4	0.030-0.040	0.035	0.0- 1.5	4	0.050-0.200	0.050	0.0- 1.5	4	0.020-0.040	0.020	0.0- 1.5
MAX DEPTH**	2	0.030-0.080	0.055	3.4- 10.7	2	0.060-0.190	0.125	4.0- 11.0	1	0.020-0.020	0.020	4.3- 4.3
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	4	0.700-1.100	0.850	0.0- 1.5	4	0.500-0.800	0.600	0.0- 1.5	4	0.200-0.600	0.500	0.0- 1.5
MAX DEPTH**	2	0.700-0.800	0.750	3.4- 10.7	2	0.400-0.600	0.500	4.0- 11.0	2	0.400-1.700	1.050	4.3- 13.7
SECCHI DISC (METERS)												
	2	0.8- 0.8	0.8		2	0.5- 0.6	0.6		1	1.5- 1.5	1.5	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units Per ml
03/04/75	1. Chroomonas?	2,587
	2. Cryptomonas	1,053
	3. Cyclotella	511
	4. Melosira	421
	5. Flagellate	391
	Other genera	1,142
	Total	6,105
06/19/75	1. Melosira	1,681
	2. Coelastrum	193
	3. Oocystis	193
	4. Cryptomonas	154
	5. Scenedesmus	135
	Other genera	696
	Total	3,052
10/06/75	1. Melosira	7,673
	2. Aphanizomenon	310
	3. Trachelomonas	194
	4. Cryptomonas	116
	5. Ankistrodesmus	116
	Other genera	466
	Total	8,875

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
03/04/75	01	11.2
	02	11.9
06/19/75	01	9.5
	02	8.7
10/06/75	01	11.2
	02	11.6

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
a. 03/04/75			
Control	0.010	0.112	0.3
0.05 P	0.060	0.112	6.1
0.05 P + 1.0 N	0.060	1.112	18.6
1.00 N	0.010	1.112	0.3
b. 10/06/75			
Control	0.035	0.260	13.0
0.05 P	0.085	0.260	14.0
0.05 P + 1.0 N	0.085	1.260	44.8
1.00 N	0.035	1.260	20.6

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum*, indicate that the potential for primary productivity of Fools Hollow Lake was moderately low during the spring sampling (03/04/75) and high during the fall sampling (10/06/75). In the May assay, a significant increase in yield occurred when phosphorus was added alone and in combination with nitrogen, indicating phosphorus limitation. The addition of only nitrogen did not result in a yield greater than that of the control. In the October assay, the addition of nitrogen alone and in combination with phosphorus, produced a significant increase in yield over that of the control, indicating nitrogen limitation at this time. The addition of phosphorus alone resulted in a yield which was not significantly greater than that of the control.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in the lake data are approximately 11/1, 8/1, and 5/1 in the spring, summer, and fall, respectively, suggesting primary limitation by nitrogen (a mean N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

*For further information regarding the algal assay test procedure and selection of test organisms, see U.S. EPA (1971).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Arizona National Guard collected monthly near-surface grab samples whenever possible from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in December 1974, and was completed in November 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Arizona District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual concentrations in Fools Hollow Creek at Station C-1 and mean annual ZZ flow.

The operator of Fairway Park Water provided monthly effluent samples and corresponding flow data. Nutrient loads for the Lakeside Laundry Mat wastewater treatment plant were estimated at 1.134 kg P and 3.401 kg N/capita/year.

A. Waste Sources:

1. Known municipal -

Name	Pop.* Served	Treatment*	Mean Flow ($m^3/d \times 10^3$)	Receiving Water
Fairway Park Water	200	Activated Sludge	0.011	Unnamed Creek
Lakeside Laundry Mat	11	Stabilization Pond	0.004**	Unnamed Creek

2. Known industrial - None

*Provided by treatment plant operator.
**Estimated at 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source		kg P/yr	% of total
a.	Tributaries (nonpoint load) -		
	A-2 Show Low Creek	95	44.2
b.	Minor tributaries and immediate drainage (nonpoint load) -	40	18.6
c.	Known municipal STP's -		
	Lakeside Laundry Mat	10	4.6
	Fairway Park Water	55	25.7
d.	Septic tanks* -	5	2.3
e.	Known industrial - None		
f.	Direct precipitation** -	10	4.6
	Total	215	100.0%

2. Outputs - A-1 Show Low Creek ---

*Estimate based on 2 campgrounds.
**Estimated (See NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Show Low Creek	2,155	56.1
b. Minor tributaries and immediate drainage (nonpoint load) -	795	20.7
c. Known municipal STP's -		
Lakeside Laundry Mat	35	0.9
Fairway Park Water	105	2.7
d. Septic tanks* -	140	3.6
e. Known industrial - None		
f. Direct precipitation** -	615	16.0
Total	3,845	100.0%

2. Outputs - A-1 Show Low Creek -----

*Estimate based on 2 campgrounds.
**Estimated (See NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Show Low Creek	<1	9

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
A-3 Show Low Creek	0.064	1.219
B-1 Unnamed Creek	0.230	1.265
C-1 Unnamed Creek	0.067	1.257

F. Yearly Loading:

	Total Yearly Phosphorus Loading (g/m^2/yr)
Estimated loading for Fools Hollow Lake	0.38

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR ARIZONA 11/26/76

LAKE CODE 0402 FOOLS HOLLOW LAKE

TOTAL DRAINAGE AREA LAKE(SQ KM) 282.3

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
0402A1	282.3	0.003	0.006	0.028	0.014	0.003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.004
0402A2	239.6	0.057	0.142	0.283	0.057	0.014	0.014	0.028	0.028	0.042	0.042	0.028	0.042	0.065
0402ZZ	42.7	0.014	0.057	0.085	0.028	0.006	0.006	0.014	0.014	0.014	0.014	0.014	0.014	0.023

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 282.3
SUM OF SUB-DRAINAGE AREAS = 282.3
TOTAL FLOW IN = 1.06
TOTAL FLOW OUT = 0.05

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
0402A1	12	74	0.0	7	0.0				
	1	75	0.0	5	0.0				
	2	75	0.0	1	0.0				
	3	75	0.0	8	0.0				
	4	75	0.008	12	0.020	26	0.0		
	5	75	0.0	11	0.0	26	0.0		
	6	75	0.003	8	0.003				
	7	75	0.0	6	0.0				
	8	75	0.0	23	0.0				
	9	75	0.0	17	0.0				
	10	75	0.0	13	0.0				
	11	75	0.0	16	0.0				
0402A2	12	74	0.051	7	0.051				
	1	75	0.057	5	0.057				
	2	75	0.142	1	0.057				
	3	75	0.425	8	0.425	8	0.425		
	4	75	0.283	12	0.425	26	0.227		
	5	75	0.014	11	0.014	26	0.008		
	6	75	0.023	8	0.017				
	7	75	0.051	6	0.042				
	8	75	0.028	23	0.028				
	9	75	0.051	17	0.057				
	10	75	0.042	12	0.045				
	11	75	0.008	16	0.008				
0402ZZ	12	74	0.006						
	1	75	0.006						
	2	75	0.006						
	3	75	0.142						
	4	75	0.085						
	5	75	0.003						
	6	75	0.003						
	7	75	0.003						
	8	75	0.003						
	9	75	0.006						
	10	75	0.008						
	11	75	0.006						

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APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/11/26
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

040201
34 16 37.0 110 04 32.0 3
FOOLS HOLLOW
04017 ARIZONA

110591

11EPALES 2111202
0045 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/04	10 20	0000	3.8	10.8	30	212	8.70	98	0.040	1.000	0.050	0.015
	10 20	0005	3.3	10.2		216	8.65	99	0.030	0.700	0.060	0.007
	10 20	0015	2.6	10.0		218	8.50	100	0.020	0.700	0.070	0.004
	10 20	0025	2.3	9.6		220	8.30	99	0.050	0.700	0.080	0.005
	10 20	0035	2.3	8.2		214	7.95	87	0.080	0.800	0.080	0.007
75/06/19	10 40	0000	16.1	4.8	21	130	6.75	80	0.200	0.800	0.120	0.029
	10 40	0005	16.1	6.2		131	7.80	78	0.050	0.500	0.030	0.018
	10 40	0015	15.7	3.0		131	7.35	76	0.200	0.600	0.040	0.017
	10 40	0036	10.4	0.2		112	7.15	77	0.190	0.600	0.030	0.029
75/10/06	16 00	0009	18.8	7.8	60	153	8.90	80	0.020K	0.200	0.020K	0.009
	16 00	0005	18.8	8.0		153	8.85	81	0.020K	0.600	0.020K	0.017
	16 00	0015	18.6	7.0		151	8.55	79	0.020K	0.400	0.020K	0.017
	16 00	0030	16.4	0.5		138	7.60	80	0.620	1.100	0.020K	0.046
	16 00	0045	15.1	2.0		153	7.90	97		1.700	0.020K	0.083

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/04	10 20	0000	0.059	11.2	
	10 20	0005	0.023		
	10 20	0015	0.014		
	10 20	0025	0.022		
	10 20	0035	0.083		
75/06/19	10 40	0000	0.128	9.5	
	10 40	0005	0.071		
	10 40	0015	0.090		
	10 40	0036	0.101		
75/10/06	16 00	0000	0.040	11.2	
	16 00	0005	0.058		
	16 00	0015	0.054		
	16 00	0030	0.167		
	16 00	0045	0.300		

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 76/11/26
NATL EUTROPHICATION SURVEY
EPA-LAS VEGAS

040202
34 16 12.0 110 04 22.0 3
FOOLS HOLLOW
04017 ARIZONA

110591

11EPALES 2111202
0015 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/03/04	14 55	0000	4.2	10.4	33	222	8.70	96	0.040	1.100	0.070	0.009
	14 55	0005	4.1	10.8		216	8.70	96	0.030	0.700	0.060	0.006
	14 55	0011	4.1	10.0		216	8.70	96	0.030	0.700	0.070	0.020
75/06/19	10 55	0000	15.8	6.2	23	132	7.90	78	0.050	0.600	0.020	0.017
	10 55	0005	15.4	6.4		128	7.90	78	0.050	0.600	0.020	0.014
	10 55	0013	14.1	6.4		124	8.00	79	0.060	0.400	0.020	0.010
75/10/06	16 15	0000	18.8	7.8		152	8.80	80	0.040	0.600	0.020K	0.011
	16 15	0005	18.8	7.6		149	8.80	84	0.020K	0.400	0.020K	0.011
	16 15	0014	18.4	7.2		149	8.90	84	0.020K	0.400	0.020K	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/03/04	14 55	0000	0.025	11.9	
	14 55	0005	0.034		
	14 55	0011	0.021		
75/06/19	10 55	0000	0.061	8.7	
	10 55	0005	0.061		
	10 55	0013	0.060		
75/10/06	16 15	0000	0.064	11.6	
	16 15	0005	0.039		
	16 15	0014	0.044		

K VALUE KNOWN TO BE LESS THAN INDICATED

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/11/30
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

0402A1
34 16 28.0 110 04 30.0 4
SHOW LOW CREEK
04 7.5 SHOW LOW N
O/FOOLS HOLLOW LAKE 110591
BNK 500 FT N END OF RD NXT TO FLS HOL CK
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/04/12	17 00		0.025	1.600	0.105	0.015	0.060

APPENDIX D
TRIBUTARY AND WASTEWATER
TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/11/30
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

0402A2
34 16 12.0 110 02 48.0 4
SHOW LOW CREEK
04 7.5 SHOW LOW
T/FOOLS HOLLOW LAKE 110501
BNK 1.7 MI NNW OF SHOW LOW
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/07	09	05	0.005	0.700	0.015	0.015	0.030
75/01/05	16	00	0.008	0.900	0.032	0.010	0.020
75/02/01	13	05	0.008	1.500	0.104	0.024	0.050
75/03/08	13	10	0.016	1.050	0.024	0.033	0.100
75/04/12	16	00	0.030	1.100	0.030	0.020	0.060
75/04/26	12	35	0.010	1.450	0.025	0.025	0.050
75/05/11	17	30	0.005	0.950	0.025	0.035	0.050
75/05/26	13	15	0.025	0.575	0.020	0.010	0.025
75/06/08	13	45	0.005	0.550	0.025	0.010	0.020
75/07/06	16	30	0.020	0.700	0.020	0.030	0.050
75/08/23	11	15	0.010	0.400	0.025	0.020	0.040
75/09/17	17	00	0.110	6.300	4.300	2.400	
75/10/12	10	30	0.005	2.400	0.040	0.060	0.100
75/11/16	11	30	0.005	1.000	0.025	0.030	0.080

STORET RETRIEVAL DATE 75/11/30
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

0402A3
34 15 15.0 110 01 40.0 4
SHOW LOW CREEK
04 7.5 SHOW LOW N
T/FOOLS HOLLOW LAKE 110591
HWYS 77/60 BRDG ABOVE STP E OF SHOW LOW
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/07	09 35		0.064	1.100	0.015	0.015	0.060
75/02/01	12 40		0.008	0.800	0.032	0.032	0.080
75/03/08	12 45		0.016	1.350	0.032	0.016	0.090
75/04/12	16 00		0.030	0.900	0.020	0.020	0.062
75/04/26	13 20		0.010	0.850	0.050	0.020	0.100
75/05/11	17 00		0.005	1.400	0.025	0.025	0.070
75/05/26			0.025	4.200	0.035	0.020	0.060
75/06/08	13 30		0.005	0.450	0.035	0.030	0.040
75/07/06	16 30		0.035	0.950	0.025	0.030	0.070
75/08/23	10 45		0.005	0.800	0.020	0.030	0.080
75/09/17	17 30		0.090	1.200	0.045	0.040	
75/10/12	10 20		0.005	0.700	0.015	0.010	0.030
75/11/16	11 45		0.005	0.850	0.015	0.010	0.025

STORET RETRIEVAL DATE 76/11/30
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

040281
34 16 12.0 110 04 34.0 4
UNNAMED STREAM
04 7.5 SHOW LOW N
T/FOOLS HOLLOW LAKE 110591
DRT RD BRDG 1.1 M N OF OLD LINDEN RD JCT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/04/12	16 45		0.015	1.250	0.020	0.040	0.230

STORET RETRIEVAL DATE 75/11/30
NATL EUTROPHICATION SU .EY
EPA- LAS VEGAS

0402C1
34 15 47.0 110 04 15.0 4
CREEK IN FOOLS HOLLOW
04 7.5 SHOW LOW N
T/FOOLS HOLLOW LAKE 110591
UNMPRVD RD BRDG 1 M NW OLD LINDEN RD JCT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/02/01	13	20	0.128	1.700	0.032	0.024	0.120
75/03/08	13	20	0.008	0.900	0.016	0.008	0.020
75/04/12	16	40	0.035	1.000	0.020	0.025	0.060

STORET RETRIEVAL DATE 75/11/30
NATL EUTHOPHICATION SURVEY
EPA- LAS VEGAS

0402XA PD0402XA P000011
34 09 00.0 109 58 00.0 4
LAKESIDE LAUNDRY MAT
04 15 MCNARY
T/FOOLS HOLLOW LAKE 110492
UNNAMED CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/06/11	13 00		0.050	13.500	0.150	33.000	46.000		0.005

STORET RETRIEVAL DATE 76/11/30
NATL EUTROPHICATION SURVEY
EPA- LAS VEGAS

0402YA AS0402YA P000200
34 15 00.0 110 02 00.0 4
FAIRWAY PARK WATER
04 15 SHOW LOW
T/FOOLS HOLLOW LAKE 110591
UNNAMED CREEK
11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/02/24			15.200	2.175	0.190	5.280	5.280	0.004	0.004
75/03/31			7.900	1.500	0.080K	6.100	6.600	0.002	0.002
75/04/28			3.300	2.000	0.050K	5.800	5.900	0.003	0.002
75/05/28	16 00		0.650	3.300	0.050K	6.400	7.600	0.003	0.003
75/06/30	15 30		0.025	33.000	21.000	8.600	12.070	0.003	0.003
75/07/29	16 00		0.075	37.000	24.000	18.000	46.000	0.003	0.003
75/08/28	11 30		0.050	45.000	31.500	5.200	15.000	0.004	0.003
75/09/30	15 00		0.300	42.000	21.000	10.500	13.000	0.002	0.003
75/10/28	10 30		0.825	40.000	25.000	5.100	7.700	0.002	0.002
75/11/28	11 30		16.000	3.500	0.059	11.000	11.500	0.001	0.001
76/01/28	15 00		26.900	1.800	0.265	11.500	12.500	0.004	0.005
76/03/01	14 00		26.000	3.200	0.380	9.800	9.900	0.002	0.002

K VALUE KNOWN TO BE LESS
THAN INDICATED

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF ARIZONA

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Arizona lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in µg/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
0401	BIG LAKE	0.032	0.090	386.000	2.900	9.000	0.007
0402	FOOLS HOLLOW	0.059	0.090	466.600	10.683	14.800	0.014
0403	LAKE HAVASU	0.015	0.170	420.231	3.948	10.800	0.005
0404	LUNA LAKE	0.182	0.050	396.250	3.400	12.200	0.131
0405	LYMAN LAKE	0.099	0.060	484.667	2.633	9.000	0.056
0406	LAKE MOHAVE	0.017	0.240	369.667	4.404	8.600	0.010
0407	LAKE PLEASANT	0.027	0.040	449.154	9.808	14.900	0.004
0408	LAKE POWELL	0.009	0.400	239.000	1.333	12.200	0.010
0409	RAINBOW LAKE	0.046	0.045	440.750	16.367	12.000	0.009
0410	ROOSEVELT LAKE	0.020	0.040	429.917	4.073	14.000	0.008
0411	SAN CARLOS RESERVOIR	0.056	0.060	474.500	14.750	14.600	0.009
3201	LAKE MEAD	0.020	0.505	453.600	1.150	8.000	0.007

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
0401	BIG LAKE	45 (5)	41 (4)	82 (9)	73 (8)	77 (8)	73 (8)
0402	FOOLS HOLLOW	18 (2)	41 (4)	18 (2)	18 (2)	9 (1)	18 (2)
0403	LAKE HAVASU	91 (10)	27 (3)	64 (7)	55 (6)	64 (7)	91 (10)
0404	LUNA LAKE	0 (0)	73 (8)	73 (8)	64 (7)	41 (4)	0 (0)
0405	LYMAN LAKE	9 (1)	64 (7)	0 (0)	82 (9)	77 (8)	9 (1)
0406	LAKE MOHAVE	82 (9)	18 (2)	91 (10)	36 (4)	91 (10)	32 (3)
0407	LAKE PLEASANT	55 (6)	95 (10)	36 (4)	27 (3)	0 (0)	100 (11)
0408	LAKE POWELL	100 (11)	9 (1)	100 (11)	91 (10)	41 (4)	32 (3)
0409	RAINBOW LAKE	36 (4)	82 (9)	45 (5)	0 (0)	55 (6)	45 (5)
0410	ROOSEVELT LAKE	68 (7)	95 (10)	55 (6)	45 (5)	27 (3)	64 (7)
0411	SAN CARLOS RESERVOIR	27 (3)	55 (6)	9 (1)	9 (1)	18 (2)	55 (6)
3201	LAKE MEAD	68 (7)	0 (0)	27 (3)	100 (11)	100 (11)	82 (9)